

UNIVERSITY OF SOUTHERN QUEENSLAND

DOPPLER IMAGING OF YOUNG SOLAR-TYPE  
STARS USING THE ANU 2.3 M SIDING SPRING  
TELESCOPE.

A dissertation submitted by  
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# Abstract

The study of surface activity on young solar-type stars provides an opportunity to improve understanding of stellar dynamos and indirectly gain insight into early solar evolution. Doppler Imaging (DI) can be used to map stellar surface activity, and utilises rotation-induced Doppler-broadening of spectral lines to calculate the surface distribution of a fundamental parameter such as temperature.

DI requires high-resolution spectroscopic observations distributed over one or more stellar rotation periods. To date only a limited number of single young solar analogues have been observed using this technique. Observations of many stars at various evolutionary states and with varying physical parameters are necessary to comprehensively constrain stellar dynamo models. These observations require long-term access to a telescope with a high-resolution echelle spectrograph to undertake multiple epoch studies of stellar activity.

This project has used the ANU 2.3 metre telescope to test Doppler Imaging with two active young stars, AB Doradus (AB Dor) and HIP43720, with the HIP43720 observations contemporaneous with the Anglo-Australian Telescope (AAT) observations.

Analysis of the AB Dor mapping and comparison of the 2.3 metre and AAT results for HIP43720 indicates that the ANU 2.3 metre telescope with its high resolution echelle spectrograph is capable of undertaking scientifically useful Doppler Imaging for stellar dynamo surveys.

# Certification of Dissertation

I certify that this dissertation contains no material accepted for the award of any other degree or diploma in any university. To the best of my knowledge, it contains no material published or written by another person, except where due reference is made in the text.

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Signature of Candidate

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Date

ENDORSEMENT

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Signature of Supervisor

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Date

# Dedication

Dedicated to Stan Ramage, the best father-in-law any girl could have. I am sorry that you never got to read it, but it is finally done. Thanks for believing in me!

Dedicated also to my parents, who passed away during this last 12 months, because of whom, I have always dared to reach for the stars and to believe all things are possible, as long as you work hard at it. Especially thanks to my Dad - who taught me to hate fences and that even a 'drover's brat' can be whatever they want to be! It just took me longer than most!

# Acknowledgments

This has been no easy task, interesting, challenging and certainly a revealing journey into self-discovery. I have learnt that a document that compiles perfectly, somehow fails dismally just before it is due to journey through the ether to one's supervisor. I have learnt what procrastination is. For one, who hates ironing with a passion, it was enlightening to be reminded how many times I chose to iron instead of sit down and write this document. The observing tasks, in spite of the vagaries of weather, telescope and instrument gremlins were the fun bit; as was the initial data reduction and the sense of discovery. But there were those frustrating times, when nothing would work and a sneaky bracket in LaTeX would take 5 hours to find; when drafts came back with seemingly more comments than the original word count. Do I regret it all? No way! Would I do it again? Too right! But, one would hope, wiser and much better organised and realising that all those early comments and warnings from my supervisors were true and the voice of experience not just nagging!

So, these have been an interesting few years. Life has a habit getting in the way of even our best intentions. Being privileged to have looked after my Father in Law prior to his passing and then losing both my parents within a year. The stress of many long interstate trips in their final months and weeks, giving up was a tempting alternative with a full time job, house, farm and a variety of animals to care for. But, being a 'drover's brat' as my Dad so liked to remind me – giving up is not in my make up! Even when the bush fires earlier this year burnt large parts of our property and provided even more excuses to avoid the writing tasks – the support and friendship of my partner Christopher, the community of Coonabarabran, the USQ team and my friends at Siding Spring I could not have got to this point. My PhD journey surely will have to be far less rocky!

I can't find the right superlative to express my thanks and appreciation to Dr Brad Carter and his wife Lynette, for their on-going support, friendship

and assistance during the last couple of years. Without their help and that of Dr Stephen Marsden and Ian Waite who have always made me feel a part of the team I would not have had the motivation to keep on keeping on.

Help was only an email, Skype or voice call away and when things seemed insurmountable, they helped put things into perspective. Stephen and Ian have been awesome in helping me get to terms with the idiosyncrasies of the data reduction software and in navigating the unique issues involved in getting it to work with 2.3metre data. Thanks have to go to Dr Gayandhi De Silva her help with telescope time proposals and helping me come to grips with reducing echelle spectra in IRAF. Dr Carolyn Brown - thanks for being the buffer this last exhausting week.

Thanks also to Dr Jean-François Donati for allowing our team access to his ESPrIT code and the permission to use his results from the AAT and to produce the 2002 map of AB Dor.

Thanks also to staff of the USQ Office of Research and Higher Degrees Staff and in particular especially Mrs Annmaree Jackson and Sophie Ivory for their assistance at being on the end of a phone and email to help me navigate the system.

There are several free online services, including: the SIMBAD database and the Vizier Service for Astronomical Catalogues, both operated at CDS, Strasbourg, France; NASA Astrophysics Data System (ADS) Data Services, operated by the Smithsonian Astrophysical Observatory (SAO); IRAF, distributed by the National Optical Astronomy Observatory and the Hipparcos and other astronomical catalogues that were essential tools used in my research.

Finally, a huge thank-you to my long suffering partner Chris, who has been so incredibly supportive of me throughout this adventure and who now knows far more about ‘spotty’ stars than he probably ever wanted to. Even though your patience has been so often sorely tested you have been my rock and when I wanted to give up, you were there to push and encourage me. Also, thanks to Judy, Sue and the rest of the ladies at the old Siding Spring Lodge and Exploratory for the coffee, chocolate and a place to hide out! Unfortunately, the Lodge was destroyed in the January 2013 fires but the memories live on! That’s all Folks!

*Weather is God’s handicap for the world’s greatest astronomers.* Olin J Eggen

# Contents

<b>Abstract</b>	<b>ii</b>
<b>Certification</b>	<b>iii</b>
<b>Dedication</b>	<b>iv</b>
<b>Acknowledgments</b>	<b>v</b>
<b>List of Figures</b>	<b>xiv</b>
<b>List of Tables</b>	<b>xvi</b>
<b>1 Solar and Stellar Magnetic Activity</b>	<b>1</b>
1.1 Introduction . . . . .	1
1.2 The Sun Today . . . . .	1
1.3 Sunspots . . . . .	2
1.4 The Solar Cycle . . . . .	5
1.5 The Solar Dynamo . . . . .	7
1.5.1 Magnetohydrodynamics . . . . .	7
1.5.2 Parker Solar Dynamo . . . . .	7
1.5.3 Babcock-Leighton Magnetic Dynamo Model . . . . .	8
1.5.4 The Omega ( $\omega$ ) Effect . . . . .	9
1.5.5 The Alpha ( $\alpha$ ) Effect . . . . .	9
1.5.6 The Interface Dynamo . . . . .	10
1.6 Stellar Activity . . . . .	11
1.6.1 Starspots as Probes of the Stellar Dynamo . . . . .	11
1.6.2 Observed Starspot Distributions . . . . .	12
1.6.3 Chromospheric Indicators . . . . .	12
1.7 Properties of Starspots . . . . .	13
1.7.1 Temperature Variations . . . . .	13



1.7.2	Spot Sizes and Filling Factors . . . . .	14
1.7.3	Spot Lifetimes . . . . .	15
1.7.4	Polar Spots . . . . .	16
1.7.5	Active Longitudes . . . . .	17
1.7.6	Differential Rotation . . . . .	18
1.8	Discussion . . . . .	19
<b>2</b>	<b>Doppler Imaging</b>	<b>20</b>
2.1	Introduction . . . . .	20
2.2	General Principles of Doppler Imaging . . . . .	21
2.3	Basic Techniques of Doppler Imaging . . . . .	24
2.4	Requirements for Doppler Imaging . . . . .	24
2.4.1	Accurate Stellar Parameters . . . . .	25
2.4.2	Projected Rotational Velocity - $v \sin i$ . . . . .	25
2.4.3	Rotation Period and Phase Coverage . . . . .	27
2.4.4	Other Important Input Parameters . . . . .	29
2.5	Discussion . . . . .	30
<b>3</b>	<b>Instrumentation, Observations and Analysis</b>	<b>31</b>
3.1	Introduction . . . . .	31
3.2	Instrumentation . . . . .	31
3.2.1	ANU 2.3-metre Telescope at Siding Spring Observatory .	31
3.2.2	High Resolution Echelle Spectrograph . . . . .	32
3.2.3	CCD Cooling . . . . .	36
3.3	DI Instrument Requirements . . . . .	37
3.3.1	Signal-to-Noise Ratio . . . . .	38
3.3.2	Spectral Resolution . . . . .	38
3.3.3	Instrumental Errors . . . . .	38
3.4	Observing Methodology . . . . .	39
3.4.1	Setup . . . . .	39
3.4.2	Observing Strategy . . . . .	39
3.5	Spectral Data Reduction, Extraction and Analysis with ESPrIT	42
3.5.1	Preparation of Data . . . . .	43
3.5.2	Geometry Correction . . . . .	44
3.5.3	Wavelength Calibration . . . . .	45
3.5.4	Intensity Spectrum Extraction . . . . .	46
3.5.5	Instrumentation Shift Correction . . . . .	47

3.5.6	Summation of the Line Profiles using Least Square Deconvolution . . . . .	47
3.5.7	Least Square Deconvolution . . . . .	48
3.5.8	Producing the Doppler Image Map . . . . .	50
3.5.9	Maximum Entropy Reconstruction . . . . .	50
3.5.10	Reformat . . . . .	52
3.5.11	<i>GScale</i> . . . . .	53
3.5.12	ZDICam . . . . .	54
3.6	Limitations of Doppler Imaging . . . . .	54
3.7	Discussion . . . . .	55
<b>4</b>	<b>Testing the Suitability of the 2.3-metre Telescope for Doppler Imaging Studies Using AB Dor</b>	<b>56</b>
4.1	Introduction . . . . .	56
4.2	AB Doradus . . . . .	57
4.3	AB Dor: Fundamental Stellar Parameters . . . . .	58
4.4	Observations January 2011 - AB Dor . . . . .	59
4.5	Determining Stellar Parameters Using Maximum Entropy Reconstruction . . . . .	63
4.5.1	$\chi^2$ -Minimisation Plot for Radial Velocity . . . . .	63
4.5.2	$\chi^2$ -minimisation Plot for $v\sin i$ . . . . .	65
4.5.3	$\chi^2$ -minimisation Plot for Stellar Inclination Angle ( $i$ ) . . . . .	66
4.6	Calculating Values for Stellar Parameters Using Radius and Period . . . . .	67
4.6.1	Calculating $v\sin i$ using the Stellar Radius and Period . . . . .	67
4.6.2	Calculating Inclination Angle ( $i$ ) from $v\sin i$ , Stellar Radius and Period . . . . .	68
4.7	Summary of Derived Stellar Parameters . . . . .	69
4.8	AB Dor Surface Features . . . . .	69
4.8.1	2.3-m Map . . . . .	69
4.8.2	AAT Map . . . . .	70
4.9	Maximum Entropy Brightness Images for AB Dor . . . . .	70
4.9.1	AAT Maximum Entropy Brightness Map for AB Dor . . . . .	76
4.10	Fractional Spottedness . . . . .	77
4.11	Tests of Robustness . . . . .	79
4.12	Conclusions . . . . .	82

<b>5</b>	<b>Simultaneous Doppler Imaging of HIP43720 (HD76298) with the ANU 2.3-metre Telescope and the AAT</b>	<b>83</b>
5.1	Introduction . . . . .	83
5.2	2.3-metre Observations . . . . .	84
5.3	Anglo-Australian Telescope (AAT) . . . . .	84
5.3.1	Telescope Instrumentation . . . . .	86
5.3.2	AAT Observations . . . . .	86
5.4	HIP43720: Stellar Parameters . . . . .	87
5.5	Surface Features . . . . .	88
5.6	Comparison Maps for HIP43720 - using the AAT and 2.3-m . .	89
5.7	HIP43720 - AAT Maximum Entropy Brightness Maps . . . . .	93
5.7.1	Summary of Stellar Parameters . . . . .	96
5.8	Summary and Conclusions . . . . .	96
<b>6</b>	<b>Conclusions and Future Directions</b>	<b>101</b>
6.1	Introduction . . . . .	101
6.2	Doppler Imaging into the Future - Long-term Monitoring for Solar-like Cycles . . . . .	102
6.3	Issues and Challenges . . . . .	102
6.4	Concluding Thoughts . . . . .	104
	<b>Works Cited</b>	<b>106</b>
	<b>Appendix A</b>	<b>118</b>
	<b>A Spectral Format Table</b>	<b>118</b>
	<b>Appendices</b>	<b>118</b>
	<b>Appendix B</b>	<b>121</b>
<b>B</b>	<b>Preliminary Survey for Southern Doppler Imaging(DI) Candidates</b>	<b>121</b>
B.1	Introduction . . . . .	122
B.2	List of Survey Stars Observed as Part of the Southern DI Candidate Survey . . . . .	125
	<b>Appendix C</b>	<b>141</b>

<b>C</b>	<b>Input File Formats for the Reduction and Analysis of Targets</b>	<b>141</b>
C.1	Preparation of Data . . . . .	141
C.2	Step 1: Geometry Correction . . . . .	143
C.3	Step 2: Wavelength Calibration . . . . .	143
C.4	Step 3: Spectra Extraction . . . . .	144
C.5	Step 4: Removing the Telluric Lines . . . . .	145
C.5.1	Typical Input File for <i>Gfit</i> . . . . .	145
C.6	Step 5 - Least Square Deconvolution . . . . .	145
C.7	Step 6: Reformatting the Line Profile Data . . . . .	146
C.8	Step 7: Imaging . . . . .	147
<b>Appendix D</b>		<b>149</b>
<b>D</b>	<b>Two Ultra-Rapidly Rotating Young Active Targets for Doppler Imaging Follow up.</b>	<b>149</b>
D.1	Introduction . . . . .	150
D.2	HIP2729 (HD3221) . . . . .	150
D.2.1	Stellar Parameters . . . . .	150
D.3	HIP108422 (HD208233) . . . . .	153
D.3.1	Stellar Parameters . . . . .	154
D.4	Summary . . . . .	156

# List of Figures

1.1	Active Region AR10486 - SOHO Image October 28, 2003. . . . .	3
1.2	High-resolution G-band Sunspot Image . . . . .	4
1.3	Sunspot Cycle . . . . .	6
1.4	The Alpha-Omega Effect . . . . .	10
1.5	Spot Size Comparison using HD12545 and the Sun . . . . .	14
1.6	Active Longitudes, Flip-Flops and Cycles on the RS CVn star $\sigma$ Gem . . . . .	17
2.1	How Doppler Imaging Works . . . . .	23
2.2	Examples of LSD Profiles with Varying Rotational Velocities . .	26
3.1	ANU 2.3-metre Advanced Technology Telescope . . . . .	32
3.2	ANU 2.3-m telescope with mirror cover open . . . . .	33
3.3	Echelle Spectrograph viewed facing the camera dewar . . . . .	34
3.4	Echelle Spectrograph Viewed from Rear . . . . .	35
3.5	Thorium Argon Arc showing asymmetry towards edge of frame .	36
3.6	Example of Bias Frame affected by Dewar filling . . . . .	37
3.7	Echelle Spectra showing orders 34 to 57 . . . . .	40
3.8	ThAr Arc Comparison: 2.3-m Echelle vs AAT UCLES . . . . .	43
3.9	Flat File in SAOImage DS9 showing orders . . . . .	45
4.1	Infra-red false colour image of AB Dor A and its close companion AB Dor C . . . . .	58
4.2	$\chi^2$ -minimisation Plot for Radial Velocity for AB Dor Jan 2011 Observations . . . . .	65
4.3	$\chi^2$ -minimisation for the $v \sin i$ for AB Dor Jan 2011 . . . . .	66
4.4	$\chi^2$ -minimisation for the Stellar Inclination Angle ( $i$ ) Values for AB Dor Jan 2011 . . . . .	66
4.5	Maximum Entropy Brightness Map for AB Dor - 2.3-m - Jan 2011 . . . . .	72

4.6	A Rectangular Doppler Imaging Spot Occupancy Map of AB Dor - 2.3-m Jan 2011 . . . . .	72
4.7	Maximum Entropy Brightness Map for AB Dor - 2.3-m - Jan 2011 using Stellar Parameters from $\chi^2$ -minimisation technique. . . . .	73
4.8	A Rectangular Doppler Imaging Spot Occupancy Map of AB Dor - 2.3-m Jan 2011 using Stellar Parameters from $\chi^2$ -minimisation technique. . . . .	73
4.9	Maximum Entropy Brightness Map for AB Dor - 2.3-m - Jan 2011 . . . . .	74
4.10	A Rectangular Doppler Imaging Spot Occupancy Map of AB Dor - 2.3-m Jan 2011 . . . . .	74
4.11	Maximum Entropy Fits to the LSD Stokes I profiles of AB Dor for January 2011 . . . . .	75
4.12	Maximum Entropy Brightness Map for AB Dor - AAT-2002 . . . . .	76
4.13	A Rectangular Doppler Imaging Spot Occupancy Map for AB Dor - AAT-2002 . . . . .	76
4.14	A Rectangular Doppler Imaging Spot Occupancy Map of AB Dor - 2.3-m Jan 2011 . . . . .	78
4.15	Plot of Surface Spot Occupancy as a Function of Latitude AB Dor Jan 2011 . . . . .	78
4.16	Spot Occupancy Maps of AB Dor for Radial Velocity Measurements (a) 29.8 km s <sup>-1</sup> , (b) 30.9 km s <sup>-1</sup> , and (c) 31.9 km s <sup>-1</sup> . . . . .	80
4.17	Spot Occupancy Maps of AB Dor for $v \sin i$ measurements (a) 88.5 km s <sup>-1</sup> , (b) 89.0 km s <sup>-1</sup> , and (c) 89.5 km s <sup>-1</sup> . . . . .	80
4.18	Spot Occupancy Maps of AB Dor for Inclination Angle Measurements (a) 50° (b) 60°, and (c) 70°. . . . .	81
5.1	Finder Chart for HIP43720 . . . . .	88
5.2	Maximum Entropy Brightness Image Combined for HIP43720 from April 1-5, 2010 on the 2.3-m. . . . .	90
5.3	Maximum Entropy Brightness Image Combined for HIP43720 on the AAT- polar projection. . . . .	91
5.4	Maximum entropy fits to the LSD Stokes I profiles of HIP43720 on 2.3-m . . . . .	92
5.5	Rectangular AAT Doppler Imaging Spot Occupancy Map of HIP43720 data . . . . .	93

5.6	Plot of surface spot occupancy (fractional spottedness) as a function of latitude of HIP43720 - AAT . . . . .	93
5.7	Rectangular 2.3-m Doppler Imaging Spot Occupancy Map of HIP43720 data . . . . .	94
5.8	Plot of surface spot occupancy (fractional spottedness) as a function of latitude of HIP43720 - 2.3-m . . . . .	94
5.9	Maximum entropy brightness image for HIP43720 using all profiles from AAT March 25 to April 5 2010 . . . . .	95
5.10	Maximum Entropy Brightness Image for HIP43720 using $\chi^2$ -minimisation on the 2.3-m data. . . . .	97
5.11	Rectangular 2.3-m Doppler Imaging Spot Occupancy Map of HIP43720 using $\chi^2$ -minimisation on the 2.3-m data . . . . .	98
5.12	Graph of $\chi^2$ versus Radial Velocity . . . . .	98
5.13	Graph of $\chi^2$ versus $v \sin i$ . . . . .	98
5.14	Graph of $\chi^2$ versus Stellar Inclination Angle ( $i$ ) . . . . .	99
B.1	LSD Profiles of Rapid Rotators from Survey . . . . .	124
B.2	LSD Profiles of 3 Spectroscopic Binary Stars Identified during the DI Survey . . . . .	125
D.1	Least-squares deconvolution profile (upper), and $H\alpha$ profile (lower), for HIP2729, taken on two separate occasions. . . . .	151
D.2	AO Classic Image Showing HIP108422 with possible companion. . . . .	153
D.3	$H\alpha$ profile for HIP108422 taken on two separate observations. . . . .	155

# List of Tables

1.1	Summary of the Fundamental Physical Characteristics of the Sun	2
2.1	Summary of Doppler Imaging Requirements	28
3.1	Summary of Observing Runs	41
3.2	Table of Spectral Types available in ATLAS	48
3.3	Input Table for use in Reformat.in	53
4.1	Listing of Fundamental Stellar Parameters for AB Dor from Literature.	59
4.2	Log of Observations for AB Dor - January 21, 2011	61
4.3	AB Dor: Radial Velocity Measurements for Epochs from 1988 - 2011	64
4.4	$\chi^2$ -minimisation Values for a range of Radial Velocity Values for AB Dor	65
4.5	$\chi^2$ Values for a range of $v \sin i$ Values for AB Dor	65
4.6	$\chi^2$ Values for a range of Stellar Inclination Angle ( $i$ ) Values for AB Dor	66
4.7	Comparison of Stellar Parameters	71
5.1	HIP43720 - Observation Log 2.3-m Telescope April 2010	85
5.2	Log of Spectropolarimetric Observations of HIP43720 - 3.9-m AAT March 25-April 5, April 2010	87
5.3	Table of the Parameters of HIP43720	88
5.4	Comparison of Stellar Parameters for HIP43720: 2.3-m and AAT	96
A.1	Spectral Format Tables for 2.3-m Telescope Echelle Spectrograph.	120
B.1	Echelle Exposure Times for Bright Magnitudes	122
B.2	List of Variable Stars Observed as part of the Search for Southern Sky DI Targets	126
C.1	FITS Header Modifications needed for 2.3-metre data to work with ESPrIT	142
C.2	Typical Input File for Creating a Master Flat	142



C.3	Typical <i>Geometry_23m</i> Input File . . . . .	143
C.4	Typical <i>wcal_23m</i> Input File . . . . .	144
C.5	Typical Input File for <i>Extract_23m</i> . . . . .	144
C.6	Typical Input File for <i>Sum_tell</i> . . . . .	145
C.7	Typical Input File for <i>Gfit_tell</i> . . . . .	145
C.8	Typical Input File for <b>Gfit</b> . . . . .	145
C.9	Typical Input for <i>sum.in</i> to create an LSD Profile . . . . .	146
C.10	Typical Input values for <i>reformat.in</i> . . . . .	146
C.11	Input Table for use in Creating <i>reformat.in</i> . . . . .	147
C.12	Typical Input Values for <i>gscale.in</i> . . . . .	147
C.13	Typical Input values for <i>zdicam.in</i> . . . . .	148
C.14	Typical Input values for <i>new.in</i> . . . . .	148
D.1	Stellar Parameters for HIP2729 . . . . .	152
D.2	Stellar Parameters for HIP108422 . . . . .	154